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WHITE PAINTED SURFACES AS A SUBSTRATE FOR RESTING AND OVIPOSITION IN *TABANUS RUBIDUS* WIEDEMANN AND RELATED HORSE FLY SPECIES (DIPTERA: TABANIDAE) ON A DAIRY FARM IN SOUTHERN CHINA

EMMETT R. EASTON AND AU YEUNG, SUI SHAN

(ERE) Associate Professor of Entomology, (AYSS) Research Associate/Interpreter, Plant Science Department, Box 2207A, South Dakota State University, Brookings, South Dakota 57007.

Abstract.—Cylindrical and rectangular white painted posts in dairy barns were preferred over black or dark substrates for resting and oviposition, respectively, in four species of Tabanidae affecting Holstein cattle in a confinement dairy operation outside of Guangzhou in the Guangdong Province of southern China. *Tabanus rubidus* Wiedemann, *T. mandarinus* Schiner, *T. crassus* Walker, *T. calidus* Walker, *T. striatus* Fabricius and *Chrysops sinensis* Walker were observed feeding on the white areas of the body of the dairy cattle. Flies were not observed to rest or feed on the black areas of the cow. *Tabanus rubidus* was also seen feeding on water buffalo, *Bubalus bubalis,* which were maintained in the open and were of a slate gray skin color. In North America many scientists have reported the attraction of horseflies to black objects but our observations, even though preliminary, suggest that white as opposed to black is the preferred color for attracting Tabanidae in southern China.

Insects affecting livestock in China have not received as much research attention in recent years when compared with the current emphasis underway on insect pests that affect agricultural crops or forest reserves. The writers were concerned about the paucity of published information available regarding livestock when some accounts report low or non-economic population levels of insect pests (C.S.C.P.R.C., 1977). In neighboring countries insects as well as acarine pests can be of economic significance. Mitzmain in the Philippines (1913, 1916) discussed the transmission of *Trypanosoma evansi* by several species of Tabanidae that can cause surra. This disease affects horses, camels and dogs and often the parasite appears as a non-pathogenic infection in cattle and buffalo. An outbreak of *T. evansi* affected buffaloes in N.E. Thailand in 1982 (Lohr et al., 1985) and local veterinarians in southern China indicated a large number of water buffaloes and a smaller number of dairy cattle suffered from this disease in 1984. The authors felt that population levels of horse flies were high enough in this area in 1985 to cause concern.

The observations made on the Tabanidae in this paper were undertaken on a government dairy farm outside of the city of Guangzhou in the Guangdong Province of southern China from May 17 to June 6, 1985. Approximately 900 Holstein

dairy animals are maintained under partial confinement conditions in separate units composed of 100 cows each. Four of the units were completely enclosed with only large unscreened windows (63.5 × 95.2 cm) and open doorways (1 m in width) permitting access by flies and other pests. Five of the units containing lactating dairy animals were without sides and only white posts or pillars supported a roof. Shade cloth or screening to form an awning was provided on the side exposed to greatest intensity from the sun. Mature lactating dairy animals were maintained in approximately six of these open units, while one closed unit contained non-lactating animals and another closed unit the calves. An exercise yard located adjacent to each unit provided a release from their stalls for the night and the cattle were then returned to their stalls in the morning. Antibacterial or germicidal treatments were applied to the exercise yards biweekly and insecticide in the form of dichlorvos was applied on a weekly basis to eliminate bacterial and insect pests. An examination of the manure in the yard did not reveal any developing flies or other dung fauna, which can be attributed to the fact that the cattle were allowed the freedom of the exercise yard at night when many of the common manure-inhabiting fly pests such as the house fly, *Musca domestica* (L.), or stable fly, *Stomoxys calcitrans* (L.), are inactive.

The cattle were scrubbed down daily and their wastes washed out of the barns with running water. This process diluted manure which entered mud lined canals where the surrounding soil was enriched for growth of elephant grass (*Pennisetum purpureum*) and maize. These mud lined canals provided what appeared to be ideal developing sites for tabanid larvae. Mature elephant grass was cut daily and provided to the cattle. A sizeable work force of approximately 200 staff allowed these intensive labor operations to be carried out with relative ease. Along with green vegetation the diet of dairy cattle was supplemented with crushed sweet potato, maize, soybean cake, bonemeal and a mineralized salt.

Materials and Methods

The Manitoba (black ball) trap used in this study was similar in design to that of Easton (1982) except that a rubber volley ball was used as the target instead of a ball made of styrofoam. In preliminary experiments the ball was suspended from a metal tripod and darkened with black ink. In later trials the ball was painted white. A glass quart jar fitted with an inward projecting screen cone was attached to the apex of the tripod to hold the insects. Two small pieces of resin insect strip placed inside the jar provided an insect kill. Dry ice in a powder form and wrapped in a newspaper was suspended from the tripod in later experiments to increase the catch.

The sticky-drum traps used in this study were similar to those of Thornhill and Hays (1972). Metal cans (26 cm in diameter and 66 cm in length) initially darkened with black ink were suspended near the ground so that the bottom of the can was approximately 30 cm above the substrate. In later experiments the cans were painted white. Transparent plastic wrap (0.5 mil) was applied to the drum and the surface covered with Tack Trap insect catching adhesive© (Chicopee Mfg. Co., Everee, Georgia).

Ectoparasitic fly fauna were observed daily on three herds of Holstein dairy cattle as well as single water buffalo from May 17 to June 4.

Table 1. *Tabanidae* attracted to three types of traps on a dairy farm near Guangzhou (Guangdong Province) in southern China, 1985.

Date	White Cylinder	Black Cylinder[a]	Black Ball Trap
31 May 1985	2[c]	1[b]	0
1 June 1985	5[c]	0	0
3 June 1985	13[c]	0	0
4 June 1985	21[c]	0	0

[a] A sticky drum trap.
[b] *Atylotus pallitarsis* (Olsufjev).
[c] *Tabanus rubidus.*

Results

Preliminary observations on livestock on this farm confirmed the presence of at least six species of tabanid, namely *T. rubidus* Wiedemann (15 females), *Tabanus striatus* Fabricius (1 female), *T. mandarinus* Schiner (4), *Tabanus crassus* Walker (1), *Tabanus calidus* Walker (3) and *Chrysops sinensis* Walker (2).

The Manitoba trap failed to capture any species of Tabanidae during the period of study from May 22 to June 4 even though numerous species of *Tabanus* were in evidence feeding on dairy cattle. Dry ice when used in conjunction with canopy traps permits an increase in the catch of insects that are blood feeding. The application of black ink to darken the canopy or shroud on May 26, however, failed to increase the effectiveness of this trap and the addition of dry ice wrapped in newspaper and suspended from the apex of the trap also was unsuccessful in attracting flies.

One female specimen of *Atylotus pallitarsis* (Olsufjev) was caught on a sticky black drum on May 22 while the trap was located approximately 20 yards from the cattle but no tabanid species were caught after the trap was moved into elephant grass approximately 400 m from cattle 2 days later.

Numbers of horseflies averaged 3–5 flies/water buffalo during any one period while 1–2 flies/animal were attracted to Holstein cattle in open doorways 1 m or greater in width.

Horseflies came into fly barns at larger windows only (window width >1 m or from open doorways). They landed only on the white portion of the cow. Flies were not observed resting or feeding on the black portions of the Holstein dairy cows and animals that were mostly black were not preferred as hosts. Flies preferred lighter areas particularly when the light color was in the area of the legs.

Female flies were noted to rest and oviposit on white surfaces, particularly pillars or posts that supported the roof of the open cattle units. No flies were noted resting on portions of the pillars or buildings painted black or areas that were soiled with cattle wastes. A search of the leaves of vegetation, namely elephant grass and maize, in the mud canals on the farm premises revealed no egg deposits. Several masses of eggs, however, were observed being laid by female flies on white pillars of the open dairy barns on May 28.

The drum was painted white on May 28 and placed near open cattle units. Table 1 indicates that the white surface as opposed to a black one was more attractive to tabanid species.

Fig. 1. Egg masses of *Tabanus rubidus*.

Ovipositional preference.—When first laid on white rectangular pillars, eggs were flat white in color and after 24 hours the egg masses became a dark grey. Approximately 205 eggs comprised each mass (Fig. 1) of 10 egg masses examined. Eggs laid on May 28 were observed to hatch on June 5 (after a 7 day period). Of three egg masses discovered on white portions of pillars on May 28, the heights the eggs were laid above the ground were 1.5, 2.1 and 3.0 m, respectively. On June 4 a total of 14 more egg masses were discovered among three livestock units. One egg mass examined was deposited 0.3 m above a cement surface, two egg masses were at a height of 1.5 m, four masses at 1.8, four masses at 2.1, one mass at 2.4 m, one mass at 3.0 m and one mass was deposited 3.7 m above the ground. The average height above the ground for the 14 egg masses was 2.0 m.

The repeated washing of waste materials below the egg masses provided a mechanism by which first instar larvae that reached water could easily be washed into the muddy canals where there was ample food material for their growth.

Discussion

The negative results with blackened trap types were puzzling in view of the success that researchers in North America (Adkins et al., 1972; Cobb and Balsbaugh, 1976; Easton, 1982, 1983; Thorsteinson, 1958; Thorsteinson et al., 1964) have had with the Manitoba or canopy trap or the results Thornhill and Hays (1972) reported with the sticky black drum. In Manitoba, the glossy black sphere is believed to be more attractive to insects than other geometric shapes because more surface area reflects sunlight (Thorsteinson et al., 1964).

According to the Manitoba, Canada studies, visual clues are important if Tabanidae are strongly attracted to glossy black targets suspended in the Manitoba

trap. However, some species such as *Tabanus atratus* Fabricius or *Tabanus punctifer* Osten Sacken that feed on livestock in North America are apparently only rarely attracted by these visual cues because neither Cobb and Balsbaugh (1976) nor Easton (1982, 1983) were able to demonstrate the attraction of *T. atratus* or *T. punctifer* to either Manitoba or sticky drum traps in South Dakota.

Hansens et al. (1971) did report that a pattern of a white square on a black background on a sticky trap was superior to black alone for the collection of the salt marsh greenhead, *Tabanus nigrovittatus* Macquart, in New Jersey, USA; however, the Manitoba or Manning traps utilizing darkened targets were more effective than sticky traps in collecting this fly.

The background topography in which the trap is placed can be important. A difference in total numbers of flies or in fly species diversity from two traps of even an identical design may be due to background topography (R. Axtell, pers. comm.). The background topography on the prairie of the Northcentral Plains in North America is probably more uniform than in the semitropical forested areas of southern China. Manitoba, Manning, and other blackened trap types may be more effective in temperate climates and less effective in tropical areas where topography is more varied due to the greater flora diversity.

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